United States Patent [19]

Miyazaki

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[45] **Date of Patent: May 29, 1990**

[54] **LIGHT METERING DEVICE WITH DETECTOR MATRIX AND MEAN VALUE DETECTION**

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[73] Assignee: **Fuji Photo Film Co., Ltd.**, Kanagawa, Japan

[21] Appl. No.: **315,113**

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Feb. 26, 1988 [JP] Japan 63-43454
Mar. 11, 1988 [JP] Japan 63-57965

[51] **Int. Cl.**[5] **H01J 40/14**
[52] **U.S. Cl.** ..... **364/525**; 250/214 P; 250/208.1; 250/208.3; 356/222; 354/432
[58] **Field of Search** ..... 250/208, 209, 214 R, 250/214 P; 356/218, 222; 354/432

[56] **References Cited**

U.S. PATENT DOCUMENTS

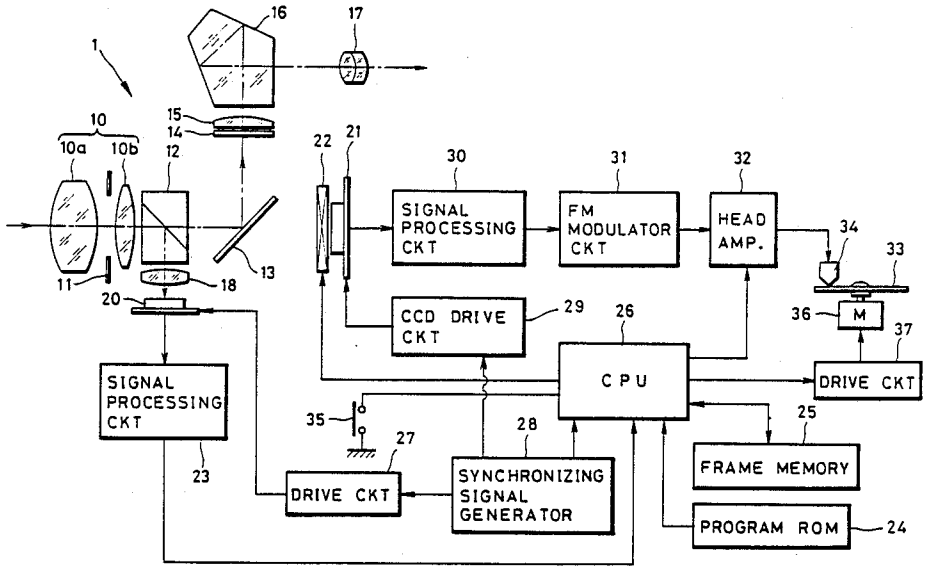
4,445,778 5/1984 Nakauchi 356/222
4,476,383 10/1984 Fukuhara et al. ..... 250/214 P

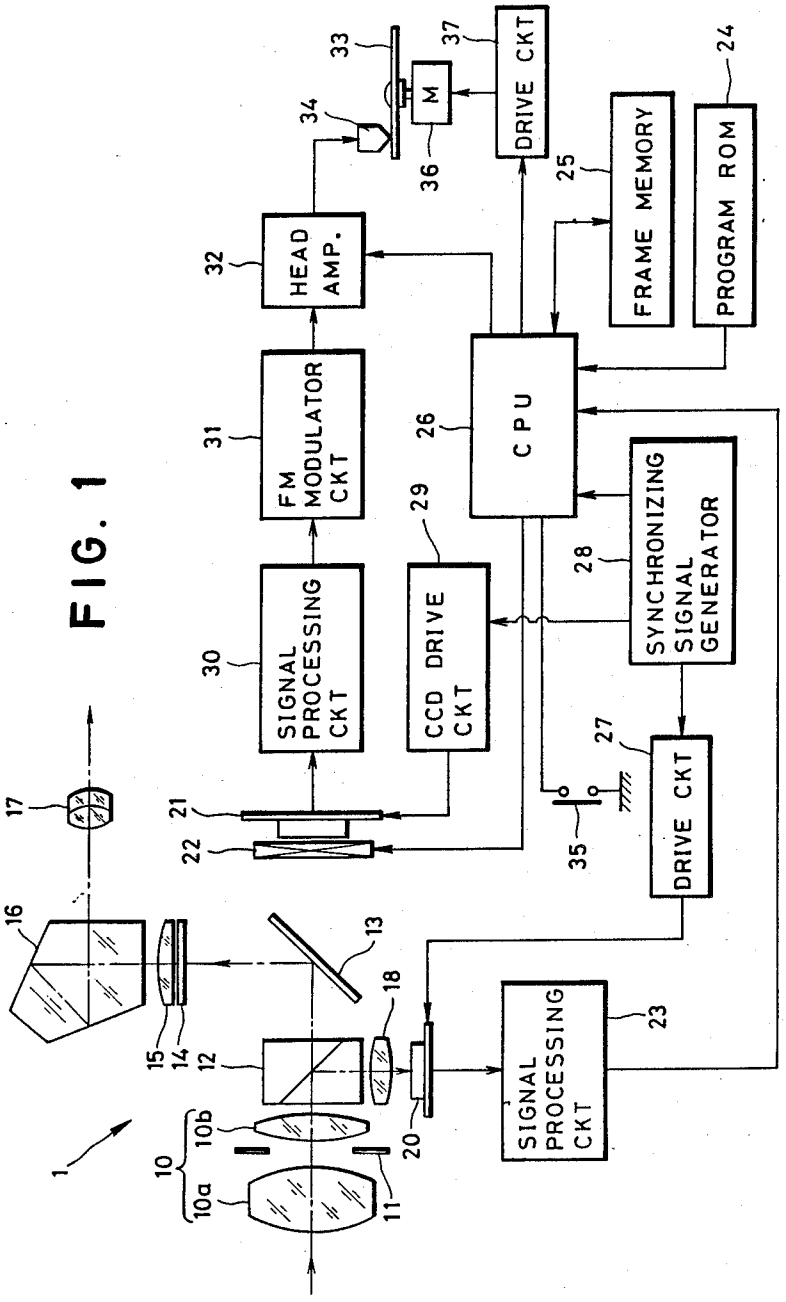
Primary Examiner—David C. Nelms

[57] **ABSTRACT**

A light metering device includes a light detecting number having a plurality of light detecting elements arranged in a matrix for detecting brightness of smaller divisions into which a whole image field is divided, respectively, to define a plurality of light metering areas different in area in an image field so as to contain a smaller light metering area within a larger light metering area, and a calculating member for obtaining a mean brightness value of each light metering area by calculating an arithmetic mean value of the outputs from the light detecting elements defining each light metering area. The difference of mean brightness values of two adjacent light metering areas is compared with a predetermined critical mean brightness value to determine that lighting condition under which a subject exists is ordinary or unusual.

9 Claims, 8 Drawing Sheets




1
10
10a
10b
11
12
13
14
15
16
17
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22
23
24
25
26
27
28
29
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31
32
33
34
35
36
37
M
DRIVE CKT
FRAME MEMORY
PROGRAM ROM
HEAD AMP.
FM MODULATOR CKT
CPU
SYNCHRONIZING SIGNAL GENERATOR
SIGNAL PROCESSING CKT
CCD DRIVE CKT
DRIVE CKT
SIGNAL PROCESSING CKT

FIG. 1

FIG. 2 A

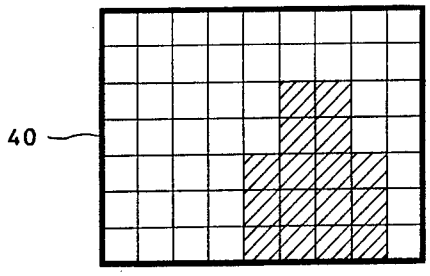


FIG. 2 B

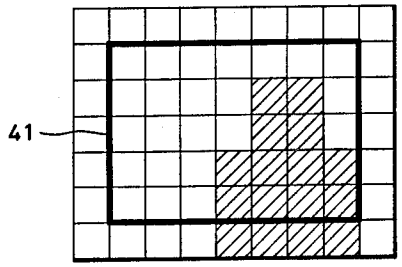


FIG. 2 C

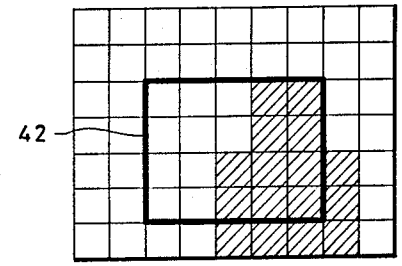


FIG. 3

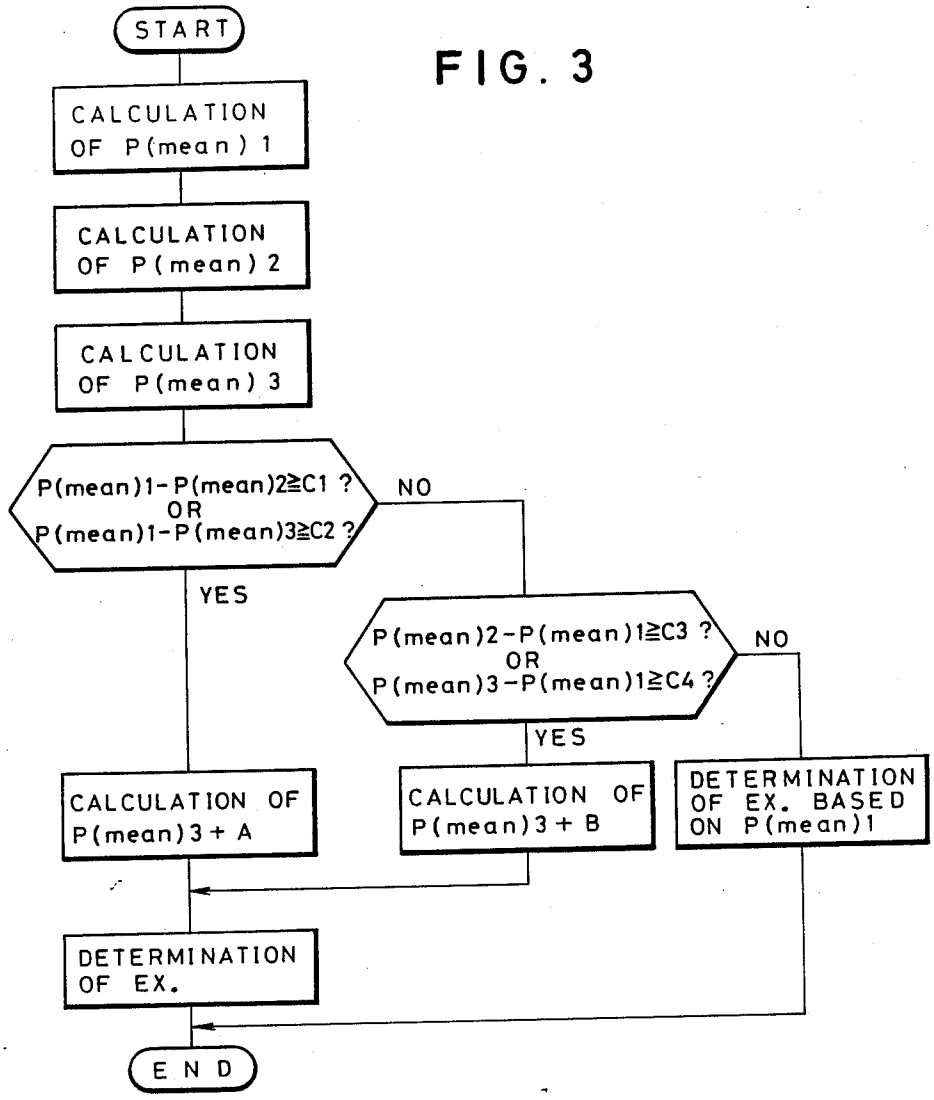

START
CALCULATION OF P(mean) 1
CALCULATION OF P(mean) 2
CALCULATION OF P(mean) 3
P(mean)1-P(mean)2≧C1 ? OR P(mean)1-P(mean)3≧C2 ?
NO
YES
P(mean)2-P(mean)1≧C3 ? OR P(mean)3-P(mean)1≧C4 ?
NO
YES
CALCULATION OF P(mean)3 + A
CALCULATION OF P(mean)3 + B
DETERMINATION OF EX. BASED ON P(mean)1
DETERMINATION OF EX.
END

FIG. 4 A

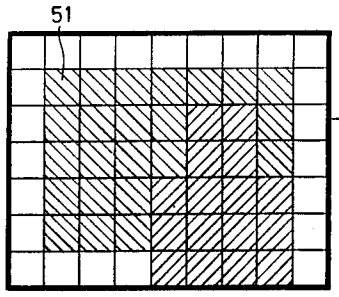


FIG. 4 B

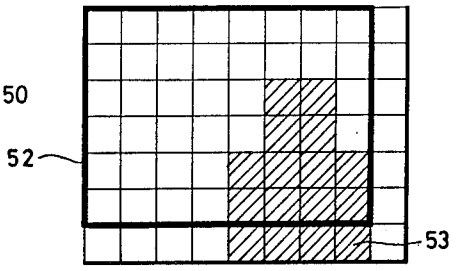


FIG. 4 C

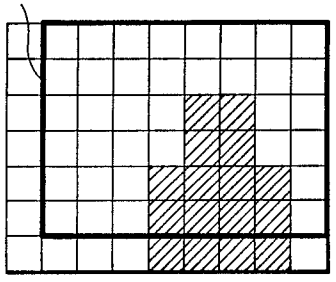


FIG. 4 D

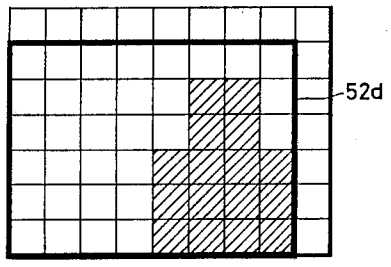


FIG. 4 E

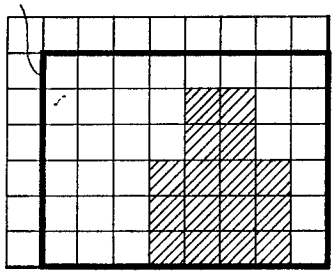


FIG. 4 F

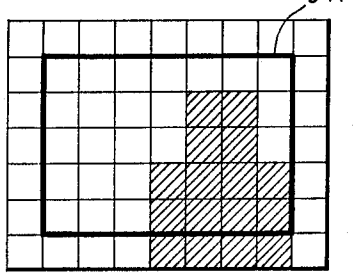


FIG. 4 G

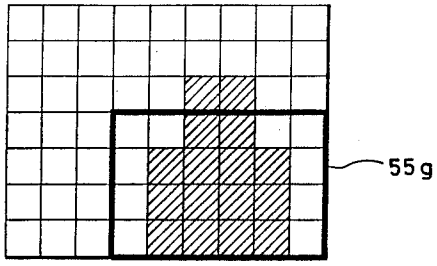


FIG. 4 H

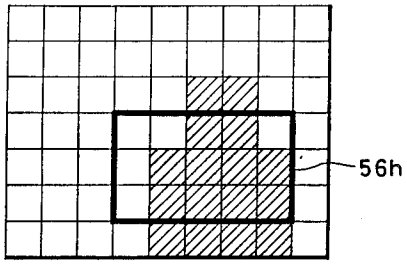


FIG. 4 I

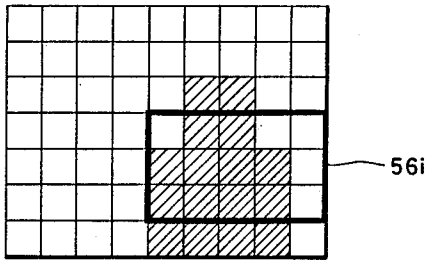


FIG. 4 J

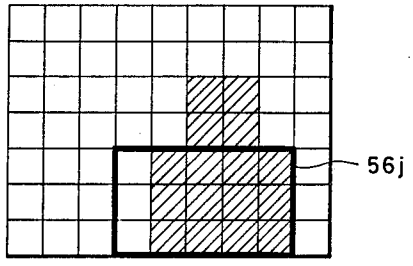


FIG. 4 K

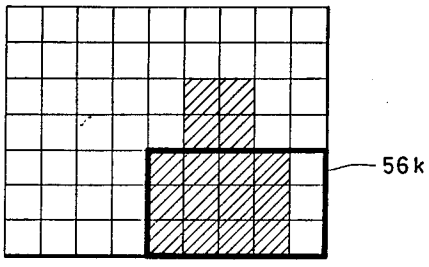


FIG. 4 L

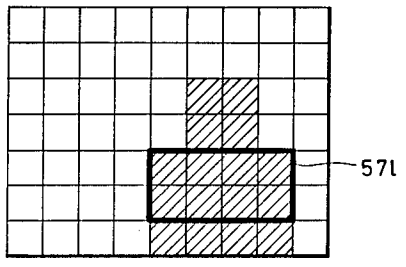


FIG. 5

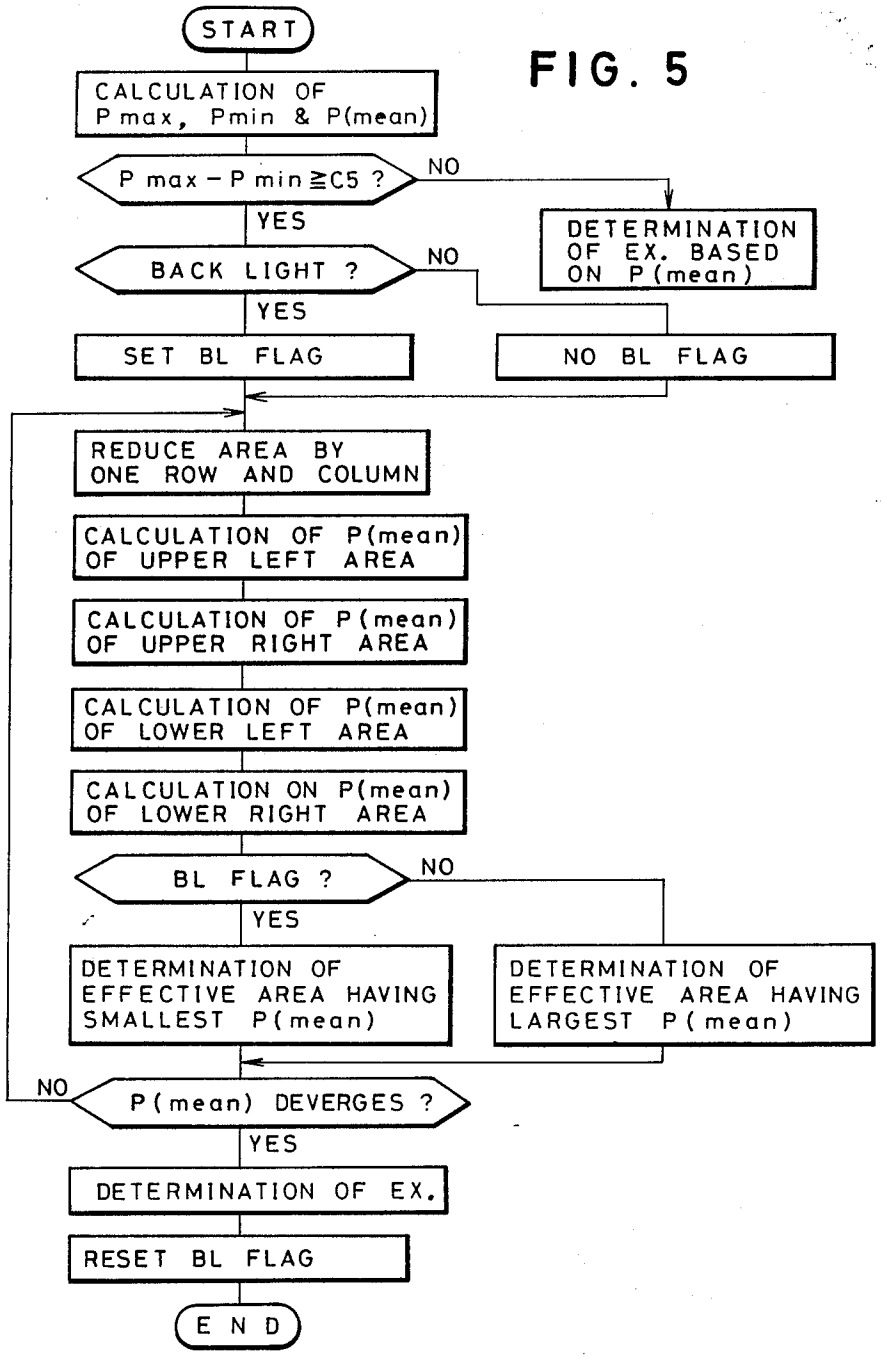

START
CALCULATION OF Pmax, Pmin & P(mean)
P max − P min ≧C5 ?
NO
YES
DETERMINATION OF EX. BASED ON P(mean)
BACK LIGHT ?
NO
YES
SET BL FLAG
NO BL FLAG
REDUCE AREA BY ONE ROW AND COLUMN
CALCULATION OF P(mean) OF UPPER LEFT AREA
CALCULATION OF P(mean) OF UPPER RIGHT AREA
CALCULATION OF P(mean) OF LOWER LEFT AREA
CALCULATION ON P(mean) OF LOWER RIGHT AREA
BL FLAG ?
NO
YES
DETERMINATION OF EFFECTIVE AREA HAVING SMALLEST P(mean)
DETERMINATION OF EFFECTIVE AREA HAVING LARGEST P(mean)
NO
P(mean) DEVERGES ?
YES
DETERMINATION OF EX.
RESET BL FLAG
E N D

FIG. 6 A

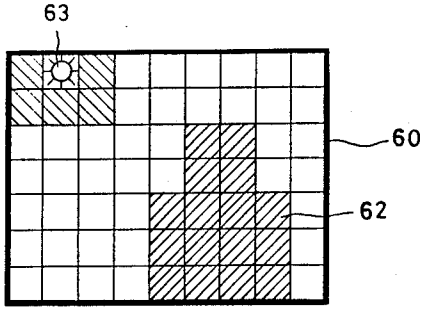


FIG. 6 B

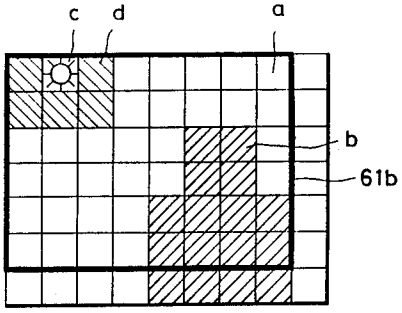


FIG. 6 C

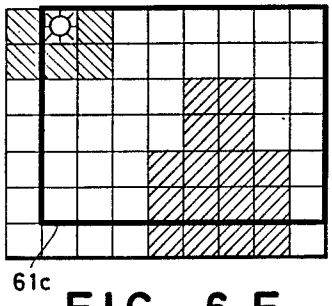


FIG. 6 D

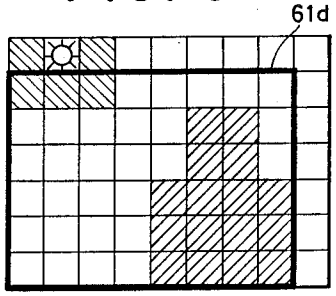


FIG. 6 E

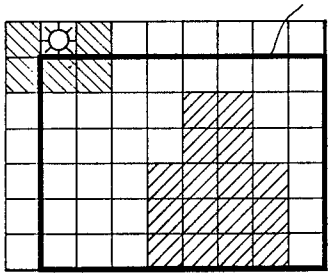
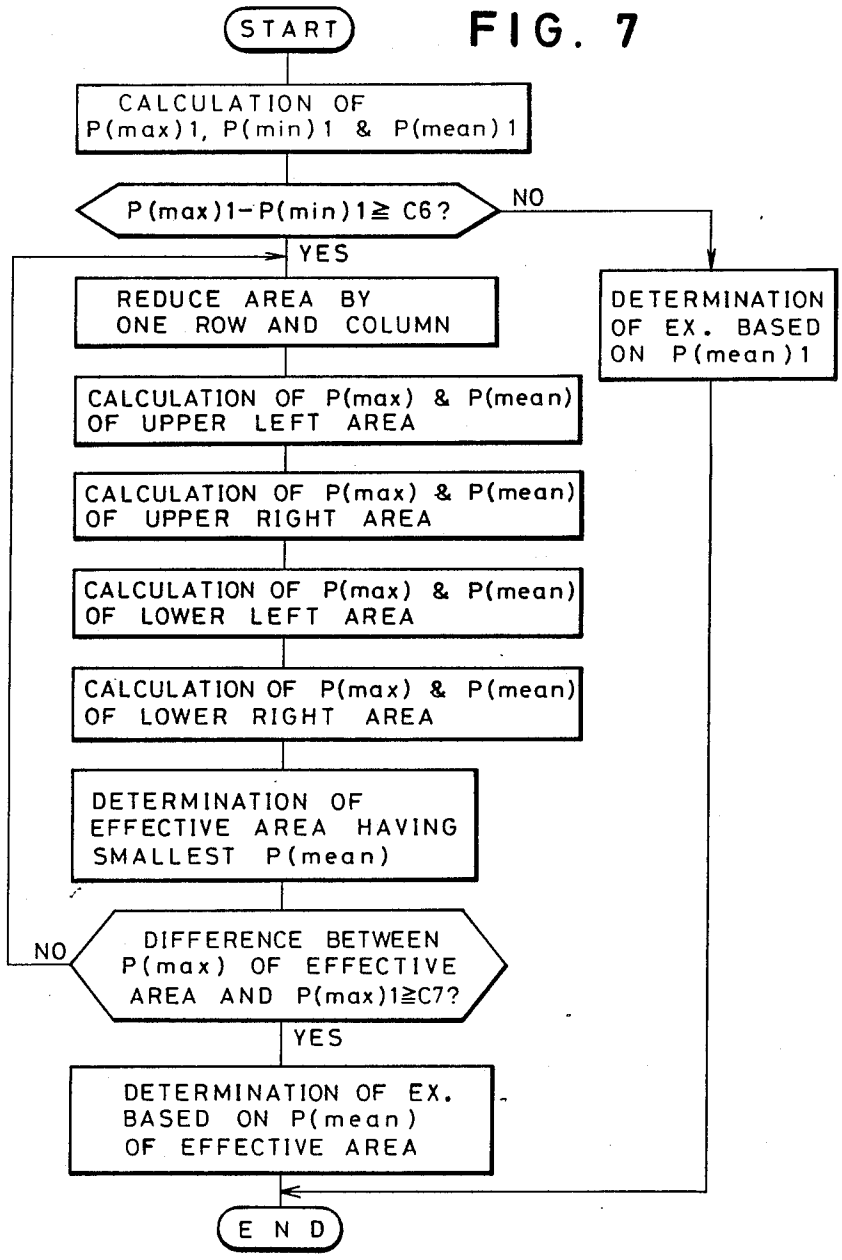


FIG. 7


START
CALCULATION OF P(max)1, P(min)1 & P(mean)1
P(max)1−P(min)1≧C6?
NO
YES
REDUCE AREA BY ONE ROW AND COLUMN
CALCULATION OF P(max) & P(mean) OF UPPER LEFT AREA
CALCULATION OF P(max) & P(mean) OF UPPER RIGHT AREA
CALCULATION OF P(max) & P(mean) OF LOWER LEFT AREA
CALCULATION OF P(max) & P(mean) OF LOWER RIGHT AREA
DETERMINATION OF EFFECTIVE AREA HAVING SMALLEST P(mean)
DIFFERENCE BETWEEN P(max) OF EFFECTIVE AREA AND P(max)1≧C7?
NO
YES
DETERMINATION OF EX. BASED ON P(mean) OF EFFECTIVE AREA
DETERMINATION OF EX. BASED ON P(mean)1
END

LIGHT METERING DEVICE WITH DETECTOR MATRIX AND MEAN VALUE DETECTION

BACKGROUND OF THE INVENTION

The present invention relates to a light metering device used in cameras such as electronic still cameras, electronic video cameras and conventional film cameras.

Generally, lighting conditions under which a subject has a brightness considerably lower than its background are referred to as a rear-lighting or backlighting condition that is one of a number of undesirable conditions for proper exposure. Detecting backlight conditions is carried out by comparing the brightness of a subject located at the center area of an image field allocated for light metering with the brightness of the background included in the image field. This is well known in the art as a spot metering system.

Meanwhile, in recent years, it has become widely popular to equip photographic cameras with improved light metering devices in order to effect proper exposures even under backlight conditions. One example of such light metering devices is disclosed in, for example, Japanese Patent Publication No. 59-33,889. The light metering device includes a light metering system having a number of photo-electric elements arranged in a plane on which an image of a subject is focused. The light metering system compares the integrated brightness value of the subject detected in a spot metering manner with that of the whole image field to determine an existing lighting condition. If the difference of integrated brightness value of a subject relative to the background or the whole image field is larger than a predetermined value, the integrated brightness value of the spot metered subject is automatically selected to determine exposure. Otherwise, if the difference of integrated brightness value of the subject relative to the background or the whole image field is smaller than the predetermined value, the integrated brightness value of the whole image field is automatically selected to determine exposure.

Another example of such light metering devices can be found in, for example, Japanese Unexamined Patent Publication No. 62-96,824. in the light metering device, outputs representing brightness for several light metering areas within the whole image field are compared with a predetermined certain value. In this manner, a proper exposure can be determined even under backlight conditions by excluding outputs beyond the predetermined certain value.

In any light metering device mentioned above, it is quite difficult to place a principal subject at the light metering center area of the image field because of possibly moving the subject. It is also difficult to manually select a spot metering area in the image field on a principal subject. These difficulties result in an inaccurate light metering.

OBJECT OF THE INVENTION

It is, therefore, an object of the present invention to provide a light metering device in which lighting conditions under which a subject exist can be automatically determined even when the subject is at any location in the image field, thereby automatically accurately providing brightness data necessary for proper exposure.

SUMMARY OF THE INVENTION

According to a preferred embodiment of the present invention, light metering device comprises light detecting means consisting of a plurality of light detecting elements arranged in a matrix for detecting brightness of smaller divisions into which a whole image field is divided, respectively, to define a plurality of light metering areas different in area in an image field so as to contain a smaller light metering area within a larger light metering area, and calculating means for obtaining a mean brightness value of each light metering area by calculating an arithmetic mean value of outputs from the light detecting elements defining each light metering area. The difference of mean brightness values of each adjacent two light metering areas is compared with a predetermined critical mean brightness value to determine if lighting condition under which a subject exists is ordinary or unusual.

When the mean brightness value of a larger light metering area is larger than that of the smaller light metering area by a predetermined or preselected certain value, it is determined that a subject is under a backlight condition, and when the mean brightness value of a smaller light metering area is larger than that of the larger light metering area by a predetermined or preselected certain value, it is determined that the subject is under a spot-light condition. Otherwise, when the difference between the mean brightness values of the larger and smaller light metering areas is between the predetermined certain values, it is determined that the subject is under an ordinary lighting condition. Lighting conditions; normal lighting conditions or unusual lighting conditions including backlight and spot-light lighting conditions, under which a subject exist can be automatically determined even when the subject is at any location in the image field unless otherwise at extremely marginal locations, the light metering device automatically accurately provides brightness data necessary for proper exposure.

According to another preferred embodiment of the present invention, a light metering device comprises; a plurality of light detecting elements arranged in a matrix to detect brightness of smaller divisions into which a whole image field is divided, respectively; means for defining a reference standard light metering area by selectively driving the light detecting elements contained in a corresponding rectangular area, defining a rectangular light metering area reduced in size depending from the reference standard light metering area, shifting the reduced light metering area in four ways so as to coincide one corner of the reduced light metering area with a corresponding corner of the reference standard light metering area one after another to detect a mean brightness value of the reduced light metering area shifted to each the corresponding corner of the reference standard light metering area, selecting one reduced light metering area having an extreme mean brightness value among the four-way shifted reduced light metering areas to determine it as another reference standard light metering area and defining another reduced rectangular light metering area depending from the another reduced light metering area; means for detecting a maximum brightness value of the respective reference standard light metering area; and means for comparing the difference of the maximum brightness values of each reference standard light metering areas and a maximum brightness value of the whole maximum

light metering area corresponding the whole image field with a determined or preselected value.

An exposure is determined based on the mean brightness value of the another reference standard light metering area when the difference between maximum brightness values becomes larger and converges the predetermined value. Backlight condition as an unusual lighting condition under which a subject exist can be automatically determined by excluding brightness data for a part of the image field which has brightness considerably higher than that of the subject when the subject is at any location in the image field, the light metering device automatically accurately provides brightness data necessary for proper exposure.

According to still another preferred embodiment of the present invention, a light metering device comprises a plurality of light detecting elements arranged in a matrix to detect a brightness of smaller divisions into which a whole image field is divided, respectively; means for defining a reference standard light metering area by selectively driving the light detecting elements contained in a corresponding rectangular area, defining a rectangular light metering area reduced in size depending from the reference standard light metering area, shifting the reduced light metering area in four ways so as to coincide one corner of the reduced light metering area with a corresponding corner of the reference standard light metering area one after another to detect a mean brightness value of the reduced light metering area shifted to each the corresponding corner of the reference standard light metering area, selecting one reduced light metering area having an extreme mean brightness value among the four-way shifted reduced light metering areas to determine it as another reference standard light metering area and defining another reduced rectangular light metering area depending from the another reduced light metering area; means for detecting a mean brightness value of the respective reference standard light metering area; and means for comparing the difference of the mean brightness values of each two adjacent reference standard light metering areas with a determined or preselected value.

An exposure is determined based on the mean brightness value of the another reference standard light metering area when the difference between the mean brightness values of the adjacent reference standard light metering areas converges the predetermined value. Unusual lighting condition, such as a backlight or spotlight lighting condition, under which a subject exist can be automatically determined even when the subject is at any location in the image field, the light metering device automatically accurately provides brightness data necessary for proper exposure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating an electronic still camera system in which the present invention is embodied;

FIGS. **2A**, **2B** and **2C** are illustrations showing various light metering areas for explaining operation of the light metering device according to a first preferred embodiment of the present invention;

FIG. **3** is a flow chart illustrating a sequence for a central processing unit which controls operation of the light metering device of the first preferred embodiment of the present invention;

FIGS. **4A**, **4B**, **4C**, **4D**, **4E**, **4G**, **4H**, **4I**, **4J**, **4K** and **4L** are illustrations showing various light metering areas for explaining operation of the light metering device according to a second preferred embodiment of the present invention;

FIG. **5** is a flow chart illustrating a sequence for a central processing unit which controls operation of the light metering device of the second preferred embodiment of the present invention;

FIGS. **6A**, **6B**, **6C**, **6D** and **6E** are illustrations showing various light metering areas for explaining operation of the light metering device according to a third preferred embodiment of the present invention; and

FIG. **7** is a flow chart illustrating a sequence for a central processing unit which controls operation of the light metering device of the third preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. **1**, a single lens reflex type electronic still camera **1** is shown having a taking lens system **10** comprising two lens groups; front or first **10***a* and rear or second **10***b*. A diaphragm **11** of the type operating quickly is disposed between the first and second lens groups **10***a* and **10***b*. A beam splitter **12** is located right behind the second lens group **10***b* and a quick return reflective mirror **13** is located behind the beam splitter **12**. Above the quick return reflective mirror **13**, a focusing screen **14** is fixedly provided substantially at a right angle. An image focused on the focusing screen **14** is viewed through a finder system comprising a condenser lens **15**, pentagonal prism **16** and eye piece **17**.

A photo-diode array **20** working as a light detector is disposed below the beam splitter **12** to receive light rays focused thereon by means of a focusing lens **18**. The photo-diode array **20**, which is a charge coupled device (CCD), has 63 photo-diode elements arranged in a seven row-nine column matrix forming a primary reference standard light metering area corresponding to and including the whole image field **40** such as shown in FIG. 2A. The taking lens system **10** focuses an image of a subject on the surface of the photo-diode array **20**. A shutter **22**, which is preferably a focal plane shutter, is disposed behind the quick return reflective mirror **13** and is positioned in a focal plane on which the taking lens system **10** focuses an image. An electronic imaging device **21** comprising a charge coupled device (CCD) is disposed right behind the shutter **22**.

A signal processing circuit **23** is, on one hand, connected to the photo-diode array **20** and, on the other hand, to a central processing unit (CPU) **26** operating various operative elements with a sequential programmed operation stored in a program ROM **24**. A frame memory **25** is connected to and controlled by the CPU **26** to store therein serial data of outputs transferred to the CPU **26** from the photo-diode array **20** through the signal processing circuit **23** in address order. The output from the photo-diode array **20** represents the light intensity of each small part of an image of the subject focused on the surface of the photo-diode array **20**. It is understood that the image is notionally divided into a number of small parts by and correspondingly to the photo-diode elements of the photo-diode array **20**. The CPU **26** controls the shutter **22** and diaphragm **11** to open and close according to a result obtained based on the data of light intensity so as to expose

the CCD imaging device **21** to the incident light. A shutter release switch **35** is connected to the CPU **26** to initiate the programmed operation of the electronic still camera **1**.

A signal processing circuit **30** is connected, on one hand, to the CCD imaging device **21** and, on the other hand, to a magnetic recording head **34** through an FM modulator circuit **31** and a magnetic head drive amplifier **32** connected to the CPU **26**. The magnetic recording head **34** records video signals on a magnetic recording medium such as a still picture floppy **33**. The still picture floppy **33** is driven at a constant speed of rotation by a known floppy drive having a motor **36** which is controlled by a drive circuit **37** connected to the CPU **26**.

The photo-diode array **20** and CCD imaging device **21** are driven by drive circuits **27** and **29**, respectively, connected to a synchronizing signal generator **28** to transfer image signals with synchronizing signals generated by the synchronizing signal generator **28**. The synchronizing signal generator **28** also generates master clock pulses for operating the CPU **26**.

In the operation of the electronic still camera **1** constructed as above, when powering the electronic still camera **1** after loading the still picture floppy **33** into the electronic still camera **1**, the synchronizing signal generator **28** generates a series of master clock pulses and sends them to the CPU **26** and drive circuits **27** and **29** for the photo-diode array **20** and CCD imaging device **21**, respectively. The CPU **26** provides the drive circuit **37** with drive signals to rotate the motor **36**, driving the still picture floppy **33**. The still picture floppy **33** will reach a constant speed of rotation of 60 revolutions per second in approximately "60" ms after the start of rotation.

Aiming the optical axis of the taking lens system **10** at a subject, light rays from the image field or scene enter into the taking lens system **10** and are divided into two parts by the beam splitter **12**; one directly directed toward the quick return reflective mirror **13** and the other reflected by the interface of the beam splitter **12** and directed toward the photo-diode array **20**. The taking lens system **10** forms an image of the subject which passes through the beam splitter **12** and then is reflected at a right angle and directed toward the focusing screen **14**. The subject image on the focusing screen **14** is viewed through the finder system and focused on the focusing screen **14** by adjusting the taking lens system **10**. When the taking lens system **10** focuses the image of the subject on the focusing screen **14**, the focusing lens **18** focuses, in cooperation with the taking lens system **10**, the subject image on the surface of the photo-diode array **20**.

The photo-diode array **20** transfers the focused subject image into brightness signals which are sent to the CPU **26** after being amplified and converted into a digital form in the signal processing circuit **23**. The CPU **26** controls the frame memory **25** to temporarily store the brightness signals therein according to the programmed sequence of operation in the program ROM **24**.

FIG. **2A** illustrates the primary reference standard light metering area defined and measured by the photo-diode array **20** including all of the photo-diode elements and therefore all data of brightness stored in the frame memory **25**. Data of the primary reference standard light metering area **40** of the image field can be recorded as magnetic signals in single or double tracks of the still picture floppy **33** allocated for one frame. FIG. **2B** illustrates a secondary light metering area **41** smaller than the first light metering area **40** shown in FIG. **2A**, and FIG. **2C** illustrates a third light metering area **42** smaller than the second light metering area **41** shown in FIG. **2B**. The secondary and third light metering areas can be defined by excluding the upper and lower lines and first and last columns of the photo-diode elements from the primary and secondary light metering areas, respectively.

Light metering in the electronic still camera **1** shown in FIG. **1** is best understood with reference to a flow chart illustration the programmed sequence of operation for the CPU **26** shown in FIG. **3**. As shown, the CPU **26** calculates a mean brightness $P_{mean}1$ of the primary light metering area **40** by dividing the sum of the values of brightness of all divisions of the primary light metering area **40** by the number of the photo-diode elements of the photo-diode array **20**. The CPU **26** calculates a mean brightness $P_{mean}2$ of the secondary light metering area **41** by dividing the sum of the values of brightness of smaller divisions of the secondary light metering area **41** by the numbr of the photo-diode elements of the photo-diode array **20** included in an area corresponding to the secondary light metering area **41**. In a same way, a mean brightness $P_{mean}3$ of the third light metering area **42** is calculated.

If the subject is back-light and is not located extremely close to the edge of light metering area such as a part defined by the boundaries of the primary and secondary light metering area **40** and **41**, the difference of mean brightness between the primary and secondary light metering areas ($P_{means}1-P_{mean}2$) is certainly equal to or larger than a certain value C1, for example "0.18". However, if a space the subject is occupying in the whole image field is small, the difference of mean brightness ($P_{mean}1-P_{mean}2$) is possibly considerably small. For this reason, in the present invention, the third light metering area **42** is provided to accurately determine whether the subject is back-lit. That is, a backlight condition is determined if the difference of mean brightness ($P_{mean}1-P_{mean}2$) is equal to or larger than the certain value C1 and the difference of mean brightness between the first and third light metering areas ($P_{means}1-P_{mean}3$) is equal to or larger than a certain value C2, for example "0.49".

For example, if assuming that the brightness value of each smaller division is aEV for the background and bEV for the subject, the mean brightness value P_{mean} in exposure value (EV) is given as follows:

$$P_{mean}1=(47a+16b)/63$$

$$P_{mean}2=(23a+12b)/35$$

$$P_{mean}3=(10a+10b)/20$$

Hence,

$$P_{mean}1-P_{mean}2=4/45\times(a-b)$$

$$P_{mean}1-P_{mean}3=31/126\times(a-b)$$

If "backlight" is assumed to be a condition that the difference (a−b) of brightness value in exposure value (EV) is not smaller than 2 EV, the above expressions can be rewritten as follows:

$$P_{mean}1-P_{mean}2\geqq 0.18$$

$P_{mean}1-P_{mean}3 \geqq 0.49$

$P_{mean}2-P_{mean}3 \geqq 0.31$

When either one of the expressions, $P_{mean}1-P_{mean}2 \geqq C1$ and $P_{mean}1-P_{mean}3 \geqq C2$ is satisfied, it is determined that the subject is under a backlight condition. If in fact the subject is determined to be backlit, after the calculation of $P_{mean}3$ plus a predetermined correction exposure value A for backlight condition, for example −0.5 EV, an exposure E is determined based on the corrected value ($P_{mean}3+A$). Taking a picture with the exposure E provides an image including the subject and background well balanced in brightness.

On the other hand, if both of the expressions, namely $P_{mean}1-P_{mean}2 \geqq C1$ and $P_{mean}1-P_{mean}3 \geqq C2$ are not satisfied, the decision is made whether the further expressions, $P_{mean}2-P_{mean}1 \geqq C3$ and $P_{mean}3-P_{mean}1 \geqq C4$ are satisfied or not. If these expressions are both satisfied, the subject is determined to be under a spot-light illumination. In this event, after the calculation of $P_{mean}3$ plus a predetermined correction exposure value B for a spot-light illumination condition, for example +0.5 EV, an exposure E is determined based on the corrected value ($P_{mean}3+A$). Otherwise, the no decision indicates that there is no difference between the primary to third light metering areas **40** to **42**. In this event, the image field is determined to be under a normal illumination and an exposure E is determined based on the value $P_{mean}1$.

The exposure E is stored by maintaining the shutter release button depressed in a half to actuate an automatic exposure lock mechanism (of which the construction and operation is well known as an AE lock mechanism to those skilled in the art and therefore need not be illustrated and described herein). Thereafter, framing an image is made through the view finder system and the shutter release button is fully depressed. The quick return mirror **13** turns up quickly simultaneously with turning-on of the release switch **35**. Immediately after this, the shutter **22** is opened and closed to black out the view finder system for a time determined based on the exposure E. As soon as the the shutter **22** is closed, the quick return mirror **13** returns to make the view finder system available. With this sequential operation, a properly controlled amount of light reaches the CCD imaging device **21** to form thereon an optical image. As was previously described, the optical image is transformed into video signals by the CCD imaging device **21** and sent to the head amplifier **32** through the signal processing circuit **30** and the FM modulator **31**. The CPU **26** controls the head amplifier **32** to drive the magnetic head **34** to momentarily record the video signals sent thereto from the CCD imaging device **21** on the still picture floppy **33**.

Referring to FIGS. **4A** through **4L** and **5** illustrating another preferred embodiment of the present invention for use with the electronic still camera **1** shown in FIG. **1**, a primary light metering area **50** corresponding to the whole image field (which is referred to as a primary standard light metering area) measured by the photo-diode array **20** including all photo-diode elements of the photo-diode array **20** and therefore all data of brightness stored in the frame memory **25**. The primary standard light metering area **50** can be recorded as magnetic signals in single or double tracks of the still picture floppy **33** for one frame.

Firstly, the CPU **26** reads from the photo-diode array **20** maximum and minimum values of brightness P_{max} and P_{min} in exposure value (EV) among divisions into which the primary standard light metering area **50** is divided into smaller divisions by the photo-diode elements of the photo-diode array **20** which are arranged in a matrix.

The first step is to decide whether the difference between the maximum and minimum values ($P_{max}-P_{min}$) is smaller than a certain value **C5**, for example 2EV. If the answer to the first decision is no, the CPU **26** calculates a mean brightness $P_{mean}1$ of the primary standard light metering area **50** by dividing the sum of the values of brightness of all divisions of the primary standard light metering area **50** by the number of the photo-diode elements of the photo-diode array **20**. An exposure E is calculated based on the mean brightness $P_{mean}1$. Otherwise, the yes decision indicates that the difference of brightness among the divisions of the primary standard light metering area **50** is large. In this event, the image field is assumed to be either under a backlight illumination or under a spot-light illumination. Therefore, a second decision is made: is "the image field under a backlight illumination?" For this decision, a comparison is made between mean brightness values $P_{mean}1$ and $P_{mean}2$ of the primary standard light metering area **50** and a smaller light metering area **51**, used as a first reference light metering area, reduced in size by exclusing the outermost lines and columns of the photo-diode elements of the photo-diode array **20** shown by a shaded area in FIG. **4A**, respectively. The primary standard light metering area **50** is determined to be under a backlight illumination if the mean brightness $P_{mean}1$ of the primary standard light metering area **50** is larger than the mean brightness $P_{mean}2$ of the second image field **51** or to be under a spot-light illumination if the mean brightness $P_{mean}1$ of the primary standard light metering area **50** is smaller than the mean brightness $P_{mean}2$ of the first reference light metering area **51**. The CPU **29** sets in its register a backlight flag (BL FLAG) indicating that the image field is back-lit if the answer is yes, or no backlight flag is set indicating that the image field is not back-lit but illuminated with a spot light if the answer is no.

Then, the CPU **26** establishes another light metering area (which is referred to as a second standard light metering area) by excluding the highest or lowest line of photo-diode elements and the first or last column of photo-diode elements from the photo-diode array **20** and calculates a mean brightness P_{mean} of the second standard light metering area. That is, the CPU **26** calculates the mean brightness $P_{mean}B$ for a second reference light metering area **52***b* which is identical in area to the second standard light metering area but shifted in location upper left as shown in FIG. **4B**; the means brightness $P_{mean}C$ for a second reference light metering area **52***c* located upper right as shown in FIG. **4C**; the mean brightness $P_{mean}D$ for a second reference light metering area **52***d* located lower left as shown in FIG. **4D**; and the mean brightness $P_{mean}E$ for a second reference light metering area **52***e* located lower right as shown in FIG. **4E**, in this order. If assuming the brightness of background of the second light metering area to be aEV and the brightness of a subject area **53** shown by a shaded area in FIGS. **4A** through **4F** to be bEV, the mean brightness is expressed as follows:

$$P_{mean}B=(36a+12b)/48$$

$P_{mean}C=(36a+12b)/48$

$P_{mean}D=(36a+12b)/48$

$P_{mean}E=(36a+12b)/48$

When the backlight flag is set, this indicates that the brightness "a" is larger than the brightness "b" and therefore the following relation is satisfied:

$$P_{mean}B=P_{mean}C>P_{mean}D=P_{mean}E$$

In this event, the CPU **26** selectively specifies one of the second reference light metering areas having a minimum brightness. If there are two or more second reference light metering areas having a minimum brightness, a second reference light metering area located lower is specified. Further, if the two lower second reference light metering areas (the third light metering areas **52***d* and **52***e* in this embodiment) have a same mean brightness ($P_{mean}D=P_{mean}E$), selectively specified is the lower right second reference light metering area, namely the second reference light metering area **52***e* in this embodiment.

The CPU **26** further establishes another smaller light metering area (which is referred to as a third standard light metering area) **54***f* as shown in FIG. **4F** by narrowing the third light metering area **52***e* selected in the above manner by excluding the lowest line and the last column of photo-diode elements of the photo-diode array **20**. In the same manner as described for the second reference light metering area, a third reference light metering area depending from the third standard light metering area **54***f* is shifted and located upper left, upper right, lower left and lower right, in the third standard light metering area **54***f* in this order, and the mean brightness is calculated for the respective third reference light metering area at each location. One, for example the third reference light metering area **55***g* as shown in FIG. **4G**, of the four possible third reference light metering areas is selected by comparing the mean brightness and narrowed by further excluding the lowest row and the last column of photo-diode elements of the photo-diode array **20**. By repeating the above procedure, a narrowed smaller light metering area is established depending from the selected third reference light metering area **55***g* to form a fourth standard light metering area. Thereafter, the fourth standard light metering area is shifted and located upper left, upper right, lower left and lower right, in the third standard light metering area **54***f* in this order, to form four fourth reference light metering areas **56***h*, **56***i*, **56***j* and **56***k* as shown in FIGS. **4H**, **4I**, **4J** and **4K**, respectively, and the mean brightness is calculated for the respective fourth reference light metering area at each location.

The CPU **26** calculates a mean brightness of the respective fourth reference light metering area shifted to the four locations; namely $P_{mean}H$ for the refernce light metering area **56***h* located lower right as shown in FIG. **4H**, $P_{mean}I$ for the reference light metering area **56***i* located lower right as shown in FIG. **4I**, $P_{mean}J$ for the reference light metering area **56***j* located lower right as shown in FIG. **4J**, $P_{mean}K$ for the reference light metering area **56***k* located lower right as shown in FIG. **4K**. The mean brightness is expressed as follows:

$P_{mean}H=(5a+10b)/15$

$P_{mean}I=(5a+10b)/15$

$P_{mean}J=(5a+10b)/15$

$P_{mean}K=(5a+10b)/15$

Therefore the following relation is satisfied:

$$P_{mean}H=P_{mean}I>P_{mean}J=P_{mean}K$$

As a result, the reference light metering area **56***k* is effectively selected. In the same manner a described above, a latest standard light metering area **57** is established depending from the selected reference light metering area **56***k* as shown in FIG. **4L**. The mean brightness of the latest standard light metering area **57** is given as follows:

$$P_{mean}L=8b/8=b$$

As apparent, the mean brightness of the latest standard light metering area **57** becoms or converges equal to the value "b" in exposure value.

An effective proper exposure E is determined based on the converged mean brightness of the value "b". At this time, the backlight flag disappears or is reset for another light metering.

It is to be understood that the value "b" precisely represents the mean brightness of a subject and, however, indicates that the lighting condition of the subject is quite similar to a spot-lighting in the image field. Accordingly, the subject can be imaged with a good reproductivity but the background often loses its details. For this reason, it is preferred to take a mean brightness, for example the mean brightness $P_{mean}B$ of the upper left second reference image field **52***b*. In this case, the effective exposure E is determined based on the value "b" and the mean brightness $P_{mean}B$ weighted, respectively. In such a way, the subject and background can be imaged and balanced in reproductivity.

If no backlight flag is set, a reference light measuring image area having a maximum mean brightness is selected for establishing another standard light metering area. Even in the case of setting no backlight flag, an effective proper exposure E can be determined in the same procedure.

Referring to FIGS. **6A** through **4E** and **7** illustrating still another preferred embodiment of the present invention for use with the electronic still camera **1** shown in FIG. **1**, a primary standard light metering area **60** (which is corresponding to the whole image field) is measured by the photo-diode array **20** including all photo-diode elements arranged in a matrix thereof and, therefore, all data of brightness is stored in the frame memory **25**. The primary standard light metering area **60** can be recorded as magnetic signals in a single or double track of the still picture floppy **33** allocated for one still picture.

Firstly, the CPU **26** reads from the photo-diode array **20** maximum and minimum values of brightness P_{max} and P_{min} in exposure value (EV) among divisions into which the primary standard light metering area **60** is divided by the photo-diode elements of the photo-diode array **20** which are arranged in a matrix.

The first step is to decide whether the difference between the maximum and minimum values ($P_{max}-P_{min}$) is smaller than a certain value **C6**, for example 2EV. If the answer to the first decision is no, the CPU **26**

calculates a mean brightness $P_{mean}1$ of the primary standard light metering area **60**. This is done by dividing the sum of the values of brightness of all divisions of the primary standard light metering area **60** by the number of the photo-diode elements of the photo-diode array **20**. An effective exposure E is calculated based on the mean brightness $P_{mean}1$. Otherwise, the yes decision indicates that the difference of brightness among the divisions of the first image field **60** is large. In this event, the whole image field or scene is assumed to be under a backlight illumination.

The backlight determination causes the CPU **26** to establish another standard light metering area (which is referred to as a secondary standard light metering area) by excluding the highest or lowest row of photo-diode elements and the first or last column of photo-diode elements from the photo-diode array **20**, and calculates a mean brightness P_{mean} of the secondary standard light metering area. That is, the CPU **26** calculates the mean brightness $P_{mean}B$ for a reference light metering area **61***b* located upper left within the secondary standard light metering area as shown in FIG. **6**B; the mean brightness $P_{mean}C$ for a reference light metering area **61***c* located upper right as shown in FIG. **6**C; the mean brightness $P_{mean}D$ for a reference light metering area **61***d* located lower left as shown in FIG. **6**D; and the mean brightness $P_{mean}E$ for a reference light metering area **61***e* located lower right as shown in FIG. **6**E, in this order. Assuming that a brightness in exposure value is aEV for a background of the secondary light metering area, bEV for a subject area **62** which is shaded in FIGS. **6**A through **6**E, cEV for the sun **63**, and dEV for an area surrounding the sun **63**, and that the relationship $c>d>a>b$ is satisfied among these brightness values, the mean brightness is expressed as follows:

$$P_{mean}B=(30a+12b+c+5d)/48$$

$$P_{mean}C=(32a+12b+c+3d)/48$$

$$P_{mean}D=(29a+16b+3d)/48$$

$$P_{mean}E=(30a+16b+2d)/48$$

From the above, it is apparent that the relationship, $P_{mean}B>P_{mean}C>P_{mean}D>P_{mean}E$ is satisfied. Therefore, the lower right reference light metering area **61***e* shown in FIG. **6**E is selected to compare the mean brightness $P_{mean}E$ with the maximum brightness $P_{max}1$. Because the maximum brightness $P_{max}E$ and $P_{max}1$ are equal to the values "d" and "c", respectively, the difference of maximum brightness ($P_{max}1-P_{max}E=c-d$) is larger than a certain value C6, for example 5EV. As a result, the mean brightness $P_{mean}E$ of the lower right reference light metering area **61***e* is selected to determine an effective exposure E. If the difference of maximum brightness ($P_{max}1-P_{max}E=c-d$) is smaller than a certain value C7, another narrowed, standard light metering area is established depending upon the reference light metering area **61***e* and the same procedure as described above is repeated.

It is to be noted that in place of determining an effective exposure E using the mean brightness $P_{mean}E$, an exposure E can be obtained by calculating the following expression:

$$\text{Exposure } E=P_{min}E+k(P_{max}E-P_{min}E)$$

where k is a constant and takes a value between zero (0) and one (1).

The above described embodiment can be applied to subjects which are illuminated in a spot-light, in the same manner with the same result.

Although the present invention has been fully described by way of the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the present invention, they should be construed as included therein.

What is claimed is:

1. A light metering device comprising:

light detecting means consisting of a plurality of light detecting elements arranged in a matrix for defining a plurality of light metering areas different in area in an image field in such a manner as to contain a smaller light metering area within a larger light metering area;

calculating means for obtaining a mean brightness value of each light metering area by calculating an arithmetic mean value of outputs from light detecting elements corresponding to each of said plurality of light metering areas; and

determining means for comparing the difference of mean brightness value between two of each said plurality of light metering areas with a predetermined certain value given for each said two light metering areas to determine lighting conditions under which a subject exists.

2. A light metering device as defined in claim **1**, wherein the lighting condition is determined to be normal when each said difference is smaller than said corresponding predetermined certain value, or otherwise unusual when any said difference is equal to or larger than said corresponding predetermined certain value.

3. A light metering device as defined in claim **2**, wherein said unusual lighting condition includes a backlight condition and a spot light condition.

4. A light metering device as defined in claim **2**, wherein the lighting condition is determined to be a backlight condition when said difference in mean brightness value of the largest light metering area relative to any one of the remaining light metering areas of said plurality of light metering areas is equal to or larger than said predetermined certain value.

5. A light metering device as defined in claim **4**, wherein the lighting condition is determined to be a spot-light condition when said difference in mean brightness value of the largest light metering area relative to any one of the remaining light metering areas of said plurality of light metering areas is between two predetermined different values.

6. A light metering device comprising:

a plurality of light detecting elements arranged in a matrix to detect brightness of smaller divisions into which a whole image field is divided, respectively;

means for defining a rectangular standard light metering area by selectively driving said light detecting elements contained in a corresponding rectangular area, defining a rectangular reference light metering area reduced in size depending from said standard light metering area, shifting said reduced reference light metering area in four ways so as to coincide one corner of said reduced reference light metering area with a corresponding corner of said

standard light metering area one after another to detect a mean brightness value of said reduced reference light metering area shifted to each said corresponding corner of said standard light metering area, selecting one reduced reference light metering area having an extreme mean brightness value among said four-way shifted reduced reference light metering areas to determine it as another rectangular standard light metering area, and defining another rectangular reduced reference light metering area depending from said another standard light metering area; means for detecting a maximum brightness value of said respective standard light metering area;

mean brightness detecting means for detecting a mean brightness value of said respective reference standard light metering area;

means for comparing said difference of said mean brightness values of each two adjacent reference standard light metering areas with a determined or preselected value; and

an exposure determining means for determining an exposure based on said mean brightness value of said another reference standard light metering area when said difference between said mean brightness values of said adjacent reference standard light metering areas converges said predetermined value.

7. A light metering device as defined in claim 6, wherein said extreme mean brightness value is the maximum mean brightness value among the four.

8. A light metering device as defined in claim 6, wherein said extreme mean brightness value is the minimum mean brightness value among the four.

9. A light metering device having a plurality of light detecting elements arranged in a matrix detect brightness of smaller divisions into which a whole image field is divided, respectively, said light metering device comprising:

means for defining a rectangular standard light metering area by selectively driving said light detecting elements contained in a corresponding rectangular area, defining a rectangular reference light metering area reduced in size depending from said standard light metering area, shifting said reduced reference light metering area in four ways so as to coincide one corner of said reduced reference light metering area with a corresponding corner of said standard light metering area one after another to detect a mean brightness value of said reduced reference light metering area shifted to each said corresponding corner of said standard light metering area, selecting one reduced reference light metering area having an extreme mean brightness value among said four-way shifted reduced reference light metering areas to determine it as another rectangular standard light metering area, and defining another rectangular reduced reference light metering area depending from said another standard light metering area; means for detecting a maximum brightness value of said respective standard light metering area;

means for comparing said difference of the maximum brightness values of said standard light metering areas and a maximum brightness value of a whole maximum light metering area corresponding a whole image field with a determined value; and

exposure determining means for determining a proper exposure based on data of brightness of a smaller one of said standard light metering areas when said difference of said maximum brightness values of said standard light metering area relative to said maximum brightness value of a light metering area corresponding to said whole image field becomes larger than a predetermined brightness value.

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